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Our File Number: 154863-00001

January 16, 2015

AZ CORP COMMISSION
DOCKET CONTROL

Arizona Corporation Commission
DOCKETED
JAN 16 2015
DOCKETED BY

ORIGINAL

Arizona Corporation Commission
Utilities Division - Docket Control
1200 W. Washington St
Phoenix, AZ 85004

RE: Ridgenose and Cliffrose Gen-Tie Transmission Lines
Docket No. E-00000D-15-0001
Ninth Biennial Electric Transmission Assessment for 2016 Through 2025

Docket Control:

Enclosed for filing in the above-referenced docket are the original and thirteen (13) copies of the 2015 Ten Year Plans for the Ridgenose and Cliffrose Gen-Tie transmission lines.

Very truly yours,

Thomas H. Campbell
LEWIS ROCA ROTHGERBER LLP

THC/jw
Enclosures

5286312_1

PLAN FOR THE RIDGENOSE SOLAR PROJECT

Submitted by LS – Ridgenose, LLC
(a project entity owned by Longview Solar LLC)
January 16, 2015

Pursuant to A.R.S. §40-360.02, LS – Ridgenose, LLC hereby submits its plan ("Plan") for the proposed Ridgenose Solar Project transmission line (the "Project").

The Project includes a 100MWac solar photovoltaic power plant (the "Power Plant") and associated 230kV transmission interconnection tie line (the "Gen-Tie"). The Arizona Corporation Commission has not yet reviewed a Certificate of Environmental Capability for the Gen-Tie. The specific items required by A.R.S. §40-360.02(C) as set forth below:

1. **The size and proposed route of any transmission lines or location of any plan proposed to be constructed:**

   The Power Plant will be located in Maricopa County, on portions of six sections of land (approximately 1,123 acres), approximately five miles southwest of Aguila, Arizona, adjacent to and south of U.S. Highway 60 (US60). The Project will include a 230-kilovolt (kV) transmission line (Gen-Tie) running approximately 0.25 miles south to connect the Power Plant to the existing Western Area Power Administration (Western) 230kV transmission line. Attached is a map showing the Power Plant and the proposed Gen-Tie.

2. **The purpose to be served:**

   The proposed Gen-Tie would enable delivery of the Power Plant's electricity by interconnecting the Power Plant to Western's transmission system. It may also be used to back-feed power to the Project site for construction and operations. The Project can provide solar energy to Arizona or California load-serving entities via Western's transmission grid.

3. **The estimated date by which the transmission line and plant will be in operation:**

   The Project is currently estimated to be in commercial operation by the end of 2016.

4. **The average and maximum power output measured in megawatts of each plant to be installed:**

   N/A

5. **The expected capacity factor for each proposed plant:**

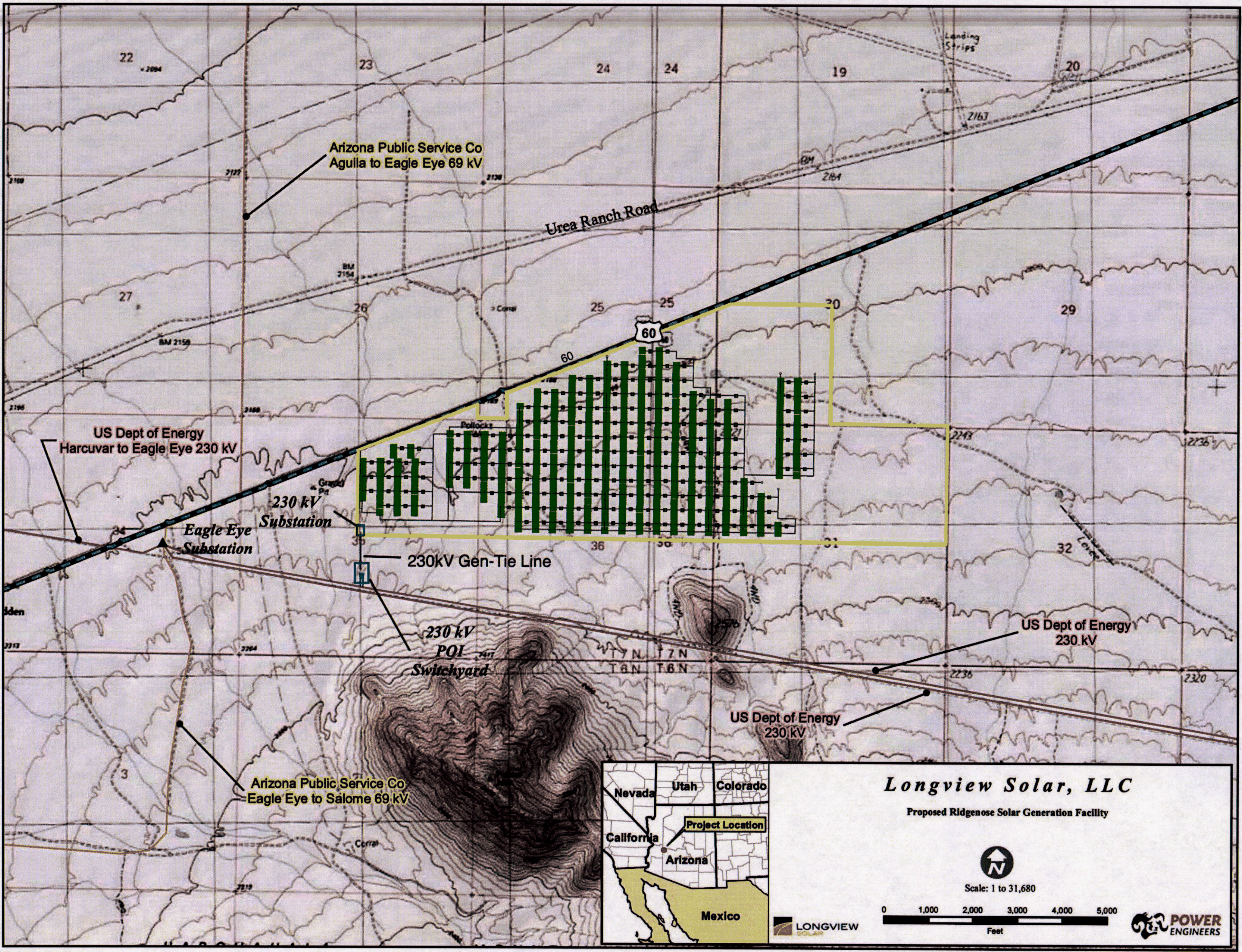
N/A

6. **The type of fuel to be used for each proposed plant:**

   N/A

7. **The plans for any new facilities shall include a power flow and stability analysis report showing the effect of the current Arizona electric transmission system. Transmission owners shall provide the technical reports, analysis or basis for projects that are included for serving customer load growth in their service territories.**

   A March 2014 Large Generator Interconnection System Impact Study ("SIS") was prepared by Western, which includes a power flow analysis and short circuit analysis. A copy of the SIS is provided herewith.



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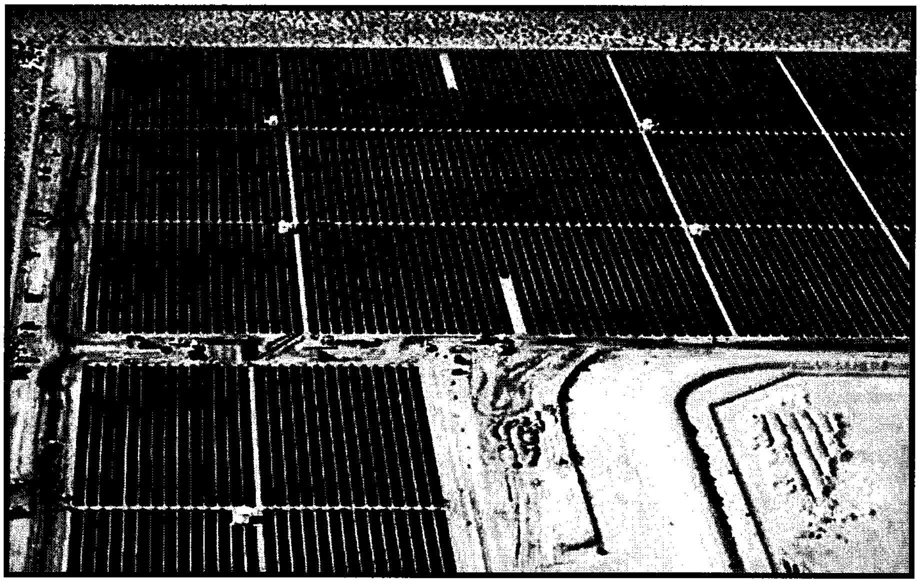
LARGE GENERATOR INTERCONNECTION

System Impact Study

2013-G33 Project



Western
AREA POWER
ADMINISTRATION

Desert Southwest Region

March 4, 2014

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LIST OF APPENDICES

1 EXECUTIVE SUMMARY

A system impact study was completed to analyze the effects of the 2013-G33 Project (Project) on the Western Area Power Administration (Western) system. The conceptual Project includes a 100 MW photovoltaic (PV) system interconnected to the existing Parker - Liberty #2 230 kV transmission line with a new interconnection substation just east of the Western/Arizona Public Service Eagle Eye substation. The Large Generator Interconnecting Customer (Customer) has requested Energy Resource Interconnection Service from Western for the Project. The planned in-service date is for January 1, 2016.

Western used a 2015 heavy summer Western Electricity Coordinating Council (WECC) base case developed in 2013. This case represents a reasonable dispatch of load and generation throughout the system based on input from WECC members during the base case building process. This case was updated to include higher priority queue projects in the vicinity of the proposed Project. The Project generation displaced generation in the Palo Verde Hub area. A sensitivity of a potential Western transmission project of looping Western's Parker - North Havasu transmission line into the Western Black Mesa substation was also included. Also, a sensitivity of the Liberty Phase Shifter set to hold 450 MW was modeled for a total of four pre-Project and four post-Project scenarios.

Power flow, transient stability, and short circuit studies were performed on the study cases. Steady state thermal and voltage violations were based on the WECC System Performance Criteria for transmission system planning. Transient stability was based on North American Electric Reliability Corporation (NERC)/WECC Stability and Post-transient Analysis Evaluation Criteria. Short circuit duties were evaluated against ratings of existing circuit breakers owned by Western.

The study results showed that none of the post-Project cases had new system performance violations on the Western study system when compared to the pre-Project cases. The Project did not cause any new power flow, voltage, transient stability, or short circuit duty violations.

Nothing in this report constitutes an offer of transmission service or determines if Western has the contractual available transmission capacity (ATC) to support the interconnection described in this report. The Customer will need to submit a Transmission Service Request to Western to evaluate what would be needed to accommodate the Project's transmission service needs.

The preliminary cost estimate to interconnect the project to the Western 230 kV system is $4 Million. An estimated schedule was developed and indicates that the Project will take three to four years to complete.

3 STUDY CASES AND ASSUMPTIONS

A pre-Project case was developed for 2015 heavy summer conditions including the LGI generation ahead of this Project in Western's queue. The queue projects added to the pre-Project case displaced generation in various locations as detailed in **Table 1**.

The General Electric (GE) Positive Sequence Load Flow (PSLF) version 18.0 software was used to analyze the pre- and post-Project study cases with respect to North American Electric Reliability Corporation (NERC) Category A, B and C events and their corresponding Western Electricity Coordinating Council (WECC) system performance criteria. GE PSLF was also used to check for new system performance criteria violations in each of the post-Project cases when compared to the corresponding pre-Project case.

3.1 Cases Studied

For the purposes of this study, Western used the WECC 2015 heavy summer case which includes a reasonable dispatch of load and generation throughout the system. Generation in the Palo Verde hub area (central Arizona) was displaced by the Project generation. A sensitivity of a potential Western transmission project of looping Western's Parker (PAD) - North Havasu (NHV) transmission line into the Western Black Mesa (BMA) substation was also included. Also, a sensitivity of the Liberty (LIB) Phase Shifter holding 450 MW was modeled for a total of four post-Project scenarios. Descriptions of the cases built and used in the study are included in **Table 1** below.

Table 1 – Cases Built for the Study

PSLF Case Name	Case Description
15hs_pre.sav	Pre-Project case with G33 Project off.
15hs_pre_bml.sav	Pre-Project case with G33 Project off, Sensitivity of the BMA loop-in modeled.
15hs_pre_phs.sav	Pre-Project case with G33 Project off, Sensitivity of the LIB phase shifter set to hold 450 MW.
15hs_pre_phs_bml.sav	Pre-Project case with G33 Project off, Sensitivity of the LIB phase shifter set to hold 450 MW, Sensitivity of the BMA loop-in modeled.
15hs_pst.sav	Post-Project case with G33 Project on.
15hs_pst_bml.sav	Post-Project case with G33 Project on, Sensitivity of the BMA loop-in modeled.
15hs_pst_phs.sav	Post-Project case with G33 Project on, Sensitivity of the LIB phase shifter set to hold 450 MW.
15hs_pst_phs_bml.sav	Post-Project case with G33 Project on, Sensitivity of the LIB phase shifter set to hold 450 MW, Sensitivity of the BMA loop-in modeled.

LGI generators that are currently higher priority in Western's LGI queue were added to the study case (see **Table 2**).

Table 2 – Queue Projects Included in the Pre-Project Case

Project Queue Number	MW	Interconnection Location	Gen Type	Generation Displaced
G5	200	Mead - Davis 230 kV Line	Wind	Southern California
G7	425	Mead - Peacock 345 kV Line	Wind	Southern California
G12	110	Bouse - Gila 161 kV Line	Solar Therm.	Southern California
G14	150	Parker - Blythe 161 kV Line	Solar Therm.	Southern California
G27	300	Liberty - Mead 345 kV Line	Wind	Southern California
G28	250	Liberty - Mead 345 kV Line	PV and Wind	Southern California

If any project ahead of this Project in Western's LGI queue drops out, then there is a possibility that a re-study may be necessary.

3.2 Transient Stability Modeling

The transient stability model for the Project was developed based on data received from the Customer. If the customer supplied dynamic data used for this study does not accurately represent the technology that will be used at the time of construction for the Project, a possible re-study may be necessary and could impact the cost and schedule of the Project. Other dynamic data, used in the transient stability simulations, came from the WECC Master Dynamics File associated with the WECC 2015 heavy summer case. Details of the Project transient stability model are included in **Appendix D**.

3.3 Short Circuit Modeling

The Steady state generator models for the Project were developed based on data received from the Customer. The contribution of fault current due to the Photovoltaic (PV) generators was negligible due to the PV models using full convert type modeling which limits fault current contributions.

3.4 Additional Assumptions

The Project will be interconnecting to an existing Western transmission line with a new Point of Interconnection substation with a ring bus design. A study area was defined to appropriately determine the impact of the Project on Western's system. If violations on neighboring systems were found, they were also monitored and reported. The main study area defined for power flow contingencies, dynamic simulation contingencies and short circuit studies includes Western's buses in the vicinity of Parker and Liberty Substations (see power flow maps in **Appendix B**). Western's ten year plan projects were modeled if they were expected to be complete by summer 2015. The ten year plans of surrounding utilities were not modeled.

The equivalenced project model for the PV generators includes no reactive power capability range. The model supplied by the Customer includes a Qmax and Qmin of zero. As the study results are based on this assumption, if the Project is not capable of maintaining a power factor within the range of 0.95 leading to 0.95 lagging at the plant's point of interconnection to Western's system, additional reactive support may be required.

4 STUDY METHODOLOGY

Defining a study methodology is necessary to analyze the power flow, short circuit and transient stability results. The study methodology defines performance criteria and provides a framework for analyzing the impact of the Project on Western's system.

4.1 Power Flow Analysis

Power flow analysis was performed on both the pre- and post-Project cases discussed above. The cases were used to simulate the impact of the Project during normal and contingency conditions. All power flow study work was conducted with version 18.0 of GE's PSLF software. Power flow results were monitored and recorded using GE PSLF's Steady State Analysis Tool (SSTOOLS) software package.

4.1.1 Power Flow System Performance Criteria

Reported thermal overloads were limited to the condition where a modeled transmission component was loaded over 100% of its appropriate normal or emergency rating (as entered in the power flow database).

As described immediately below, violations of steady-state voltage criteria were based on minimum acceptable voltages, maximum acceptable voltages, and maximum acceptable post-transient voltage deviations.

Consistent with industry practice, for NERC A normal N-0 (no contingency) conditions, voltage criteria violations were defined as per unit voltages less than 0.95 or greater than 1.05 on all buses less than 500 kV; and, as per unit voltages less than 1.00 or greater than 1.10 for 500 kV buses. For NERC B (single contingency) and NERC C (multiple contingency) conditions, voltage criteria violations were defined as per unit voltages less than 0.90 or greater than 1.10 on all buses less than 500 kV; and, as per unit voltages less than 0.95 or greater than 1.10 for 500 kV.

In addition to steady-state minimum and maximum voltage criteria, per the WECC post-transient voltage deviation criteria in **Table 3**, voltage deviations between the pre-contingency and post-contingency conditions were reported whenever greater than 5% for NERC B (single contingency) conditions; and, whenever greater than 10% for NERC C (multiple contingency) conditions.

The Project must be capable of maintaining a power factor within the full range of 0.95 leading to 0.95 lagging at the plant's point of interconnection to Western's system.

4.1.2 Power Flow Analysis Process

The system was simulated with static Var devices active, load tap changing in service, phase shifter controls active, and area interchange applied for pre-contingency conditions. For contingency conditions, the system was simulated with static Var device, load tap changer, phase shifter, and area interchange settings fixed at pre-contingency settings. For contingencies that resulted in a loss of 20 MW or more, generation in California, Nevada, and Arizona participated in a redispatch of generation to account for the lost generation or increased system power losses.

The contingencies simulated included:

- All single transmission circuit outages within the study area (NERC B).
- All single transformer outages within the study area (NERC B).
- The Project equivalent generator outage (NERC B).
- Credible multiple contingencies within the study area (NERC C).

The contingency lists were initially generated using GE PSLF's "sstools-outage-v4.p" program. These lists were then customized to apply to the study with changes such as modeling breaker-to-breaker outages and modeling multiple lines connected through a tap. The list of contingencies used for the study's scenarios can be found in **Appendix C.**

4.2 Transient Stability

Transient stability studies were performed to ensure system stability following a 3-phase fault on the system. Transient stability analysis was completed for pre-Project and post-Project conditions. Prior to finalization of the dynamics data set, various "bump" tests were run to ensure true power system behavior is not masked by any remote dynamic modeling anomalies.

Transient stability analysis, based on WECC Disturbance-Performance Criteria, was performed for selected system contingencies. Initial transient stability contingency simulations were performed out to 10 seconds. If system performance was not assessed with confidence, simulation times up to 20 seconds were used to evaluate system damping. Under normal fault clearing times for NERC B and C contingencies, all 345 kV and 500 kV contingency faults simulated a 3-phase 4-cycle fault clearing time; and, all lower voltage contingency faults simulated a 3-phase 5-cycle fault clearing time. Under delayed fault clearing times for NERC C contingencies, a 3-phase 15-cycle fault clearing time was simulated. **Appendix E** contains the switch decks used to run the transient stability simulations.

Table 3 and **Figure 2** are excerpts from the WECC System Performance Criteria and were used to evaluate NERC Categories A, B, and C events that were simulated in this study.

Table 3 – NERC/WECC Stability and Post-transient Analysis Evaluation Criteria

NERC and WECC Categories	Outage Frequency Associated with the Performance Category (outage/year)	Transient Voltage Dip Criteria	Minimum Transient Frequency Criteria	Post Transient Voltage Deviation Criteria
A System normal	Not Applicable	Nothing in addition to NERC		
B One element out of service	≥ 0.33	Not to exceed 25% at load buses or 30% at non-load buses. Not to exceed 20% for more than 20 cycles at load buses.	Not below 59.6Hz for 6 cycles or more at a load bus.	Not to exceed 5% at any bus.
C Two or more elements out of service	0.033 – 0.33	Not to exceed 30% at any bus. Not to exceed 20% for more than 40 cycles at load buses.	Not below 59.0Hz for 6 cycles or more at a load bus.	Not to exceed 10% at any bus.
D Extreme multiple-element outages	< 0.033	Nothing in addition to NERC (except WECC PCUR requirements)		

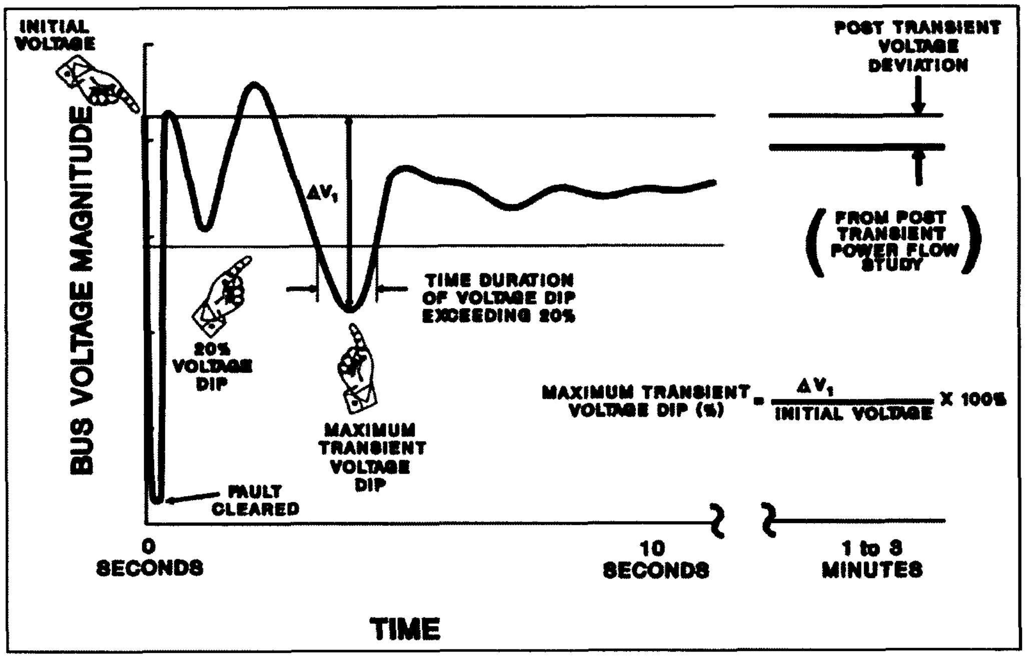


Figure 2: Graphical Representation of Stability Analysis Evaluation Criteria

All transient stability simulations were conducted using version 18.0 of GE's PSLF software. A modified version of the WECC-distributed "Alldyns.p" program was used to model operations specific to transient stability analysis.

The Worst Condition Analysis (WCA) tool, available in the GE PSLF PLOT software package, tracks and records the transient stability behavior of all output channels contained within the binary output file of a transient stability simulation. The monitoring of channel output was set to begin three cycles after fault clearing to ensure that all stability behavior would be accurately captured. The output results from the WCA program were used to report any NERC/WECC Performance Criteria violations. System damping was assessed visually with the aid of stability plots obtained through GE PSLF PLOT software.

The following monitored parameters were used to evaluate system stability performance:

- Bus Voltage
- Bus Frequency
- Generator Terminal Voltage
- Generator Frequency
- Generator Rotor Angle

4.3 Short-Circuit Duty

Short-circuit duty analysis applies three-phase faults at the specified buses in the Project study area. The calculated short-circuit data is then compared to the current interrupting capability at each breaker location. Short-circuit studies were performed for pre-Project and post-Project conditions using GE PSLF Version 18.0.

5 RESULTS

The 2013-G33 Project was analyzed based on its impact to Western's system in addition to surrounding systems. The power flow, transient stability, and short circuit analyses are described below.

5.1 Power Flow Results

The addition of the Project into Western's system did not result in any significant adverse impacts to Western's system or to neighboring systems. There were no new thermal overload, voltage, or post transient voltage deviation violations due to the Project for both NERC B and C contingencies. For the complete results, including all the contingency events simulated, see **Appendix A**. The power flow plots of any violations are included in **Appendix B**. A list of contingencies simulated for each scenario is included in **Appendix C**.

5.2 Transient Stability Analysis Results

In the Western system, after comparing pre-Project and post-Project NERC B and NERC C contingencies with normal and delayed fault clearing, it was noted that no additional WECC System Performance Criteria violations were created by the proposed Project.

Transient Stability plots are included in **Appendix F**. Worst Condition Analysis (WCA) Reports that include any stability violations of the WECC System Performance Criteria are included in **Appendix G.**

5.3 Short-Circuit Duty Results

A summary of the 3-phase fault study results at the buses most affected by the Project are shown in **Table 3**. The table includes the pre-Project and the post-Project three-phase fault currents (Amps) and the change in three-phase fault currents (Δ Amps) that occur due to the addition of the Project. As indicated in **Table 4**, the three-phase bus fault currents (Δ Amps) added by the Project are negligible. The Project generator model used, being a full converter model, acts like an open circuit during faults (infinite impedance). This lowers the overall fault current magnitude at the faulted buses. If the actual PV converter model (that will be placed into service) does not end up having this type of response, the largest fault contribution from a typical PV system would be around an additional 10% of full plant output. Either way, the fault contribution from the Project is expected to be negligible.

Table 4 – Three Phase Short Circuit Results for the Proposed Project

Faulted Bus	kV	Pre-Amps	Post-Amps	Δ Amps
Liberty	230	32,975	32,988	13
Parker	230	11,487	11,494	7
Eagle Eye	230	4,915	4,916	1

6 STANDARD INTERCONNECTION REQUIREMENTS

The results from the System Impact Study work have shown that no new system violations were reported in the study as a result of the Project so no mitigation other than the standard requirements for interconnection will be required. As part of the construction of the 2013-G33 Project, the following items will also be required:

1. The Project will need to meet Western's Open Access Transmission Tariff (OATT) power factor requirement of 0.95 leading to 0.95 lagging, as measured at the Project's 230 kV Point of Interconnection, with the Project's maximum full-output reactive power capability available at all MW output levels. It is this 2013-G33 Project's reactive power capability which may be dispatched by the Western Operations Dispatch personnel as appropriate due to system conditions and without any monetary compensation to the Customer. The equivalenced Project plant model, as supplied by the Customer for its Photovoltaic (PV) generators, includes no reactive power capability for the steady state model. Because the study results are based on this plant model, if the Project cannot operate to this level of power factor requirement, then additional Var support may be required.
2. The Project will need to include an automatic voltage control system in support of NERC and WECC dynamic reliability requirements (e.g., VAR-001-Voltage and Reactive Control) within the conditions outlined in item 1 above.
3. The Project will need to meet compliance with industry power quality standards (e.g., IEEE Standard 519) to mitigate possible adverse transmission system impacts created by the operation of electronic converters in the planned 2013-G33 Project.

7 COST ESTIMATE

The total estimated facility cost for the new 2013-G33 Project is summarized in **Table 5**. Cost estimates do not include the costs associated with planning, land and rights, communications, environmental, surveys, geologic investigations, designs and specifications, construction supervision, coordinating construction outages, or adjusting transmission service commitments during construction outages. These additional costs, as well as refinement of estimates provided in this report, can be determined in the Facility Study. The cost estimates in this report are relatively high-level, appropriate to a System Impact Study, and would be refined in the Facility Study.

Table 5 - 2013-G33 Project Conceptual Cost Estimate

Substation	Estimate	Comments
Assumptions		1. Estimate does not include any Lands or Environmental Activities.
		2. Assume Customer will be designing and Constructing the Generation - T/L.
		3. Western will construct all items from the first pole outside of the substation.
		4. No Construction contract can be awarded until all Environmental Activites have been completed.
		5. Conceptual Estimate is for Substation work only.
		6. Estimate is base on a 4 breaker ring design.
		7. Estimate does not include any communication Activities. Western will need to complete a communications study review of the area to determine the type of communication need to support the control requirements.
		8. 230 kV and greater substations will require dual communication paths for operation needs.
New G33 POI Substation	$ 4,000,000.00	Assume a breaker and half bay addition.
Total	**$ 4,000,000.00**	

The conceptual schedule estimate requires about three to four years to complete. Assumptions for the schedule:

1. Schedule may need to be adjusted base on Equipment deliveries.
2. Schedule may need to be adjusted for possible environmental issues.

8 CONCLUSIONS

A System Impact Study was performed to analyze the impact of the 2013-G33 Project on Western's system. The addition of the Project into Western's system did not result in any significant adverse impacts to Western's system or to neighboring systems. The interconnection did not result in any thermal overloads, voltage, voltage deviations, transient stability, or short circuit fault duty violations based on the criteria described in this report.

The total good faith estimate facility cost is approximately $4 million. The project will take three to four years to construct and place in service.

PLAN FOR THE CLIFFROSE SOLAR PROJECT

Submitted by LS – Cliffrose, LLC
(a project entity owned by Longview Solar LLC)
January 16, 2015

Pursuant to A.R.S. §40-360.02, LS – Cliffrose, LLC hereby submits its plan ("Plan") for the proposed Cliffrose Solar Project transmission line (the "Project").

The Project includes a 45MWac solar photovoltaic power plant (the "Power Plant") and associated 230kV transmission interconnection tie line (the "Gen-Tie"). The Arizona Corporation Commission has not yet reviewed a Certificate of Environmental Capability for the Gen-Tie. The specific items required by A.R.S. §40-360.02(C) as set forth below:

1. **The size and proposed route of any transmission lines or location of any plan proposed to be constructed:**

   The Power Plant will be located in Mohave County, on approximately 350 acres, located between the Hualapai Mountains (approximately 6 miles to the east) and the Black Mountains (approximately 5 miles to the west), in Golden Valley, Arizona, and 0.4 mile west of Interstate 40 (I-40). The Project will include a 230-kilovolt (kV) transmission line (Gen-Tie) running approximately 3 miles south to connect the Power Plant to the existing Western Area Power Administration (Western) Griffith substation. Attached is a map showing the Power Plant and the proposed Gen-Tie.

2. **The purpose to be served:**

   The proposed Gen-Tie would enable delivery of the Power Plant's electricity by interconnecting the Power Plant to Western's transmission system. It may also be used to back-feed power to the Project site for construction and operations. The Project can provide solar energy to Arizona or California load-serving entities via Western's transmission grid.

3. **The estimated date by which the transmission line and plant will be in operation:**

   The Project is currently estimated to be in commercial operation by the end of 2016.

4. **The average and maximum power output measured in megawatts of each plant to be installed:**

   N/A

5. **The expected capacity factor for each proposed plant:**

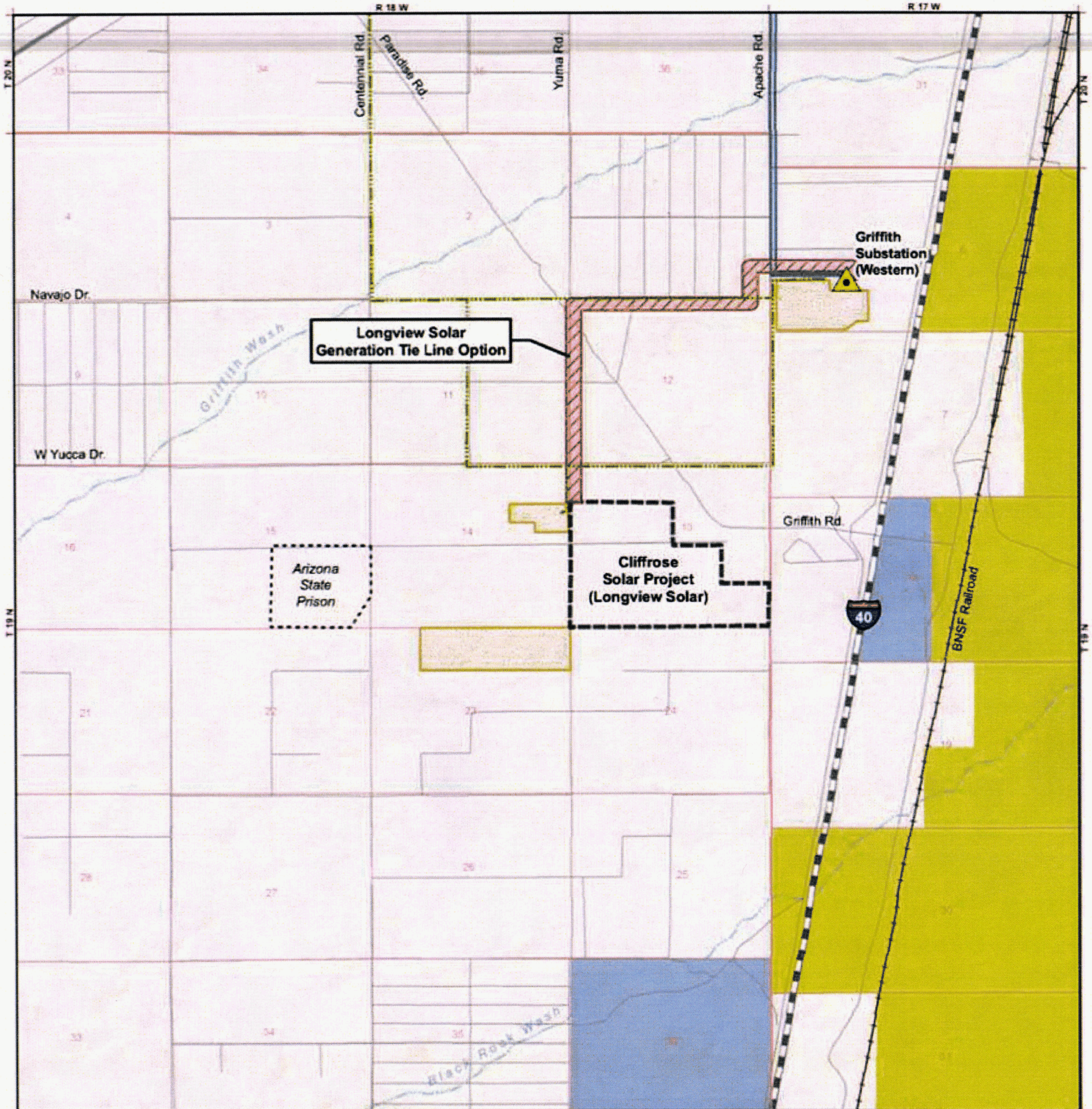
N/A

6. **The type of fuel to be used for each proposed plant:**

   N/A

7. **The plans for any new facilities shall include a power flow and stability analysis report showing the effect of the current Arizona electric transmission system. Transmission owners shall provide the technical reports, analysis or basis for projects that are included for serving customer load growth in their service territories.**

   A March 2014 Large Generator Interconnection System Impact Study ("SIS") was prepared by Western, which includes a power flow analysis and short circuit analysis. A copy of the SIS is provided herewith.



Cliffrose Solar Interconnection Project

DOE/EA-1989

Legend

- Solar Site Boundary (Longview Solar)
- Longview Solar Generation Tie Line
- Existing Energy Project
- Existing Substation (Western)
- Existing 230kV Transmission Line
- Existing 69kV Transmission Line

Land Ownership

- BLM
- State
- Private

General Reference Features

- Local Road
- Railroad
- Streams/Washes
- Township Boundary
- Section Boundary

0 0.25 0.5 0.75 1

Miles

Western

LARGE GENERATOR INTERCONNECTION

System Impact Study

Queue 2013-G32, Cliffrose Photovoltaic Solar

Western AREA POWER ADMINISTRATION

Desert Southwest Region

March 11, 2014

1 EXECUTIVE SUMMARY

A system impact study was completed to analyze the effects of the Queue 2013-G32 on the Western Area Power Administration (Western) system as an Energy Resource Interconnection. The conceptual Project is a photovoltaic (PV) system producing 50MW of net generation. The Project has a proposed in-service date for commercial operation of January 2016, and is interconnected to the existing Griffith 230 kV bus through a tie line to a new substation labeled Cliffrose. To perform this study, Western used a Western Electricity Coordination council (WECC) 2015 heavy summer base case updated to reflect all higher priority queue projects in the vicinity of the proposed Project. The project was studied in and out of service, and a sensitivity of the Liberty Phase Shifter holding its maximum flow was also studied. Transmission service has not been evaluated as part of this system impact study.

The results of this study indicate that the Project does not significantly affect the reliability of the transmission system, and thus the Project will not need to upgrade the system in order to interconnect. These results are further explained in the Results section of this report.

For the planned interconnection to the Western 230 kV system the estimated cost is about $3 million and will take two to three years to complete, not including environmental activities.

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LIST OF APPENDICES

2 INTRODUCTION

The Large Generator Interconnecting Customer (Customer) has requested Energy Resource Interconnection Service from Western Area Power Administration (Western) for the 2013-G32 Project (Project). Pursuant to the Large Generator Interconnection Procedure of Western's Open Access Transmission Tariff, a System Impact Study has been conducted to evaluate the impact of the proposed interconnection on the reliability of the transmission system. The conceptual Project includes a photovoltaic system connected to the existing Griffith 230 kV bus through a 3.4 mile tie line to a new substation labeled Cliffrose. The Project will produce a total of 50 MW. The planned in-service date is January 2016. A general diagram of the project interconnection point is shown in **Figure 1**.

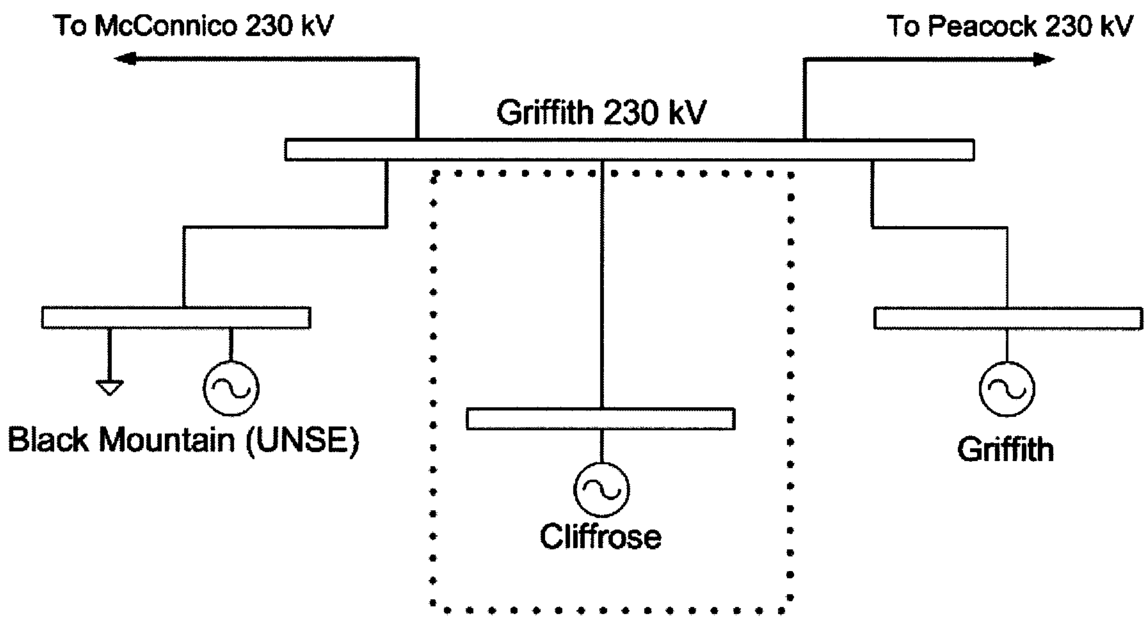

Figure 1 – Project Interconnection Point

The technical analysis performed in this study included power flow, transient stability, and short circuit analysis. Assumptions and modifications to the cases, along with a technical analysis of the Project's impact on the cases, follow in the subsequent sections.

Nothing in this report constitutes an offer of transmission service or confers upon the requested interconnection any right to receive transmission service. This system impact study tries to identify and mitigate only those possible new technical reliability violations of the interconnected system identified in a limited set of simulations. Despite the results of these technical interconnection studies, the Western system and other interconnected utilities may not have the contractual available transmission capacity (ATC) to support the interconnection described in this report. In fact, no transmission service request has been made by this Project nor has any possible transmission service associated with this project been evaluated as part of this system impact study.

3 STUDY CASES AND ASSUMPTIONS

3.1 Cases Studied

A WECC 2015 heavy summer base case developed in 2013 was used as the starting case for this study. This case represents a reasonable dispatch of load and generation throughout the system. The case was chosen because it was readily available and models the most severe system conditions during a timeframe close to the in-service date of the Project. Four cases were developed from this starting case. These include both a pre-Project and post-Project case each modeling the Liberty phase shifter holding its maximum flow and the Liberty phase shifter bypassed. **Table 2** describes the cases that were used for this study.

PSLF Case Name	Description
15hs_pre.sav	2015 Heavy Summer Base Case; Project Off. (No generation displacement)
15hs_pre_phs.sav	2015 Heavy Summer Base Case; Liberty Phase Shifter holding maximum flow; Project Off. (No generation displacement)
15hs_pst.sav	2015 Heavy Summer Base Case; Project On. (Project generation displacement at the Palo Verde Hub area)
15hs_pst_phs.sav	2015 Heavy Summer Base Case; Liberty Phase Shifter holding maximum flow; Project On. (Project generation displacement at the Palo Verde Hub area)

Table 1 – Study Cases

Queue generation was inserted into the case if it was in the vicinity of the Project and has a higher queue position than the Project. The models for these queue projects were placed into the study cases as provided by their applicants. The effects of queue generation from surrounding systems were also considered, but no other projects were determined necessary to include in the base case. The included queue generation projects are described in **Table 2.**

Queue Number	Location	MW
2006-G5	Mead – Davis 230 kV Line	300
2007-G7	Mead – Peacock 345 kV Line	425
2008-G12	Bouse – Kofa 161 kV Line	110
2009-G14	Parker – Blythe 161 kV Line	150
2011-G27	Mead – Peacock 345 kV Line	300
2012-G29	Mead 230 kV	180

Table 2 – Queue Projects Included in Study[1]

All Queue projects were dispatched to their maximum capability and generation was displaced by reducing generation in the Southern California area.

3.2 Transient Stability Modeling

The transient stability model for the Project was developed based on data received from the Customer, the WECC master dynamics file, dynamics data submitted by other queue applicants, and Black Mountain generator models from prior Western studies.

3.3 Additional Assumptions

New substations were assumed to be configured as ring bus designs. Western's ten year plan projects were modeled if they were expected to be complete by summer 2015. The ten year plans of surrounding utilities were not modeled. A study area was defined to appropriately determine the impact of the Project on the system. The study area is shown in **Appendix A.**

[1] Queue projects 2010-G20 and 2011-G28 left the queue during the course of this study . After 2010-G20 left, that project was removed from all base cases and simulations files. When 2011-G28 left the queue, the studies for the Project were substantially complete. In the interest of time and resources, only the steady-state simulations were re-performed without 2011-G28. The transient stability simulations with 2011-G28 in the cases were determined to be adequate since that project was "netted out" in those simulations.

4 STUDY METHODOLOGY

The General Electric (GE) Positive Sequence Load Flow (PSLF) version 18 software was used to analyze the pre- and post-Project study cases with respect to North American Electric Reliability Corporation (NERC) Category A, B, and C events and their corresponding WECC system performance criteria. GE PSLF was also used to check for new system performance criteria violations in each of the post-Project cases when compared to the corresponding pre-Project case.

This section of the report provides a summary of methods employed for determining the power flow, short circuit, and transient stability results. The study methodology defines performance criteria and provides a framework for analyzing the impact of the Project on Western's system.

4.1 Power Flow Analysis

Power flow analysis was performed on all four of the cases discussed above. The cases were used to simulate the impact of the Project during normal and contingency conditions. All power flow study work was conducted with version 18 of GE's PSLF software. Power flow results were monitored and recorded using GE PSLF's Steady State Analysis Tool (SSTOOLS) software package.

The system was simulated with static VAR devices active, load tap changing in service, phase shifters active and area interchange applied for pre-contingency conditions. The SANTN 5S bus was used to balance area interchange mismatches inside Arizona (Area 14) for pre-contingency conditions. For contingency conditions, the system was simulated with static VAR devices deactivated, load tap changing out of service, phase shifters blocked and area interchange disabled. Governor response, utilizing base load flags, across Arizona (Area 14) was used to redispatch generation after contingencies which islanded or tripped generation. A swing bus located at PTSB 7 in the PG&E control area balanced mismatches in the system for pre-contingency and post-contingency conditions.

Thermal and voltage performance were evaluated under NERC Category A, B, and C contingencies of the facilities in the study area. The list of contingencies is included in **Appendix B**.

The NERC Standards, WECC System Performance Criteria and the following criteria were used to assess the adequacy of the study results:

- Pre-contingency bus voltages, between 100 kV and 499 kV, must be between 0.95 per unit and 1.05 per unit, unless specific minimum operating voltage requirements exist.
- Pre-contingency bus voltages, 500 kV and above, must be between 1.0 per unit and 1.08 per unit, unless specific minimum operating voltage requirements exist.
- Post-contingency bus voltages, between 100 kV and 499 kV, must be between 0.90 and 1.10 per unit, unless specific minimum operating voltage requirements exist.

- Post-contingency bus voltages, 500 kV and above, must be between 0.90 and 1.10 per unit, unless specific minimum operating voltage requirements exist.
- Maximum post-transient voltage deviation allowed at all buses under contingency conditions will be 5% for all NERC B contingencies and 10% for all NERC C contingencies.
- Pre-disturbance loading to remain within continuous ratings of all equipment and line conductors.
- Post-disturbance loading to remain within emergency ratings of all equipment and line conductors.

The NERC Category C analysis included N-1-1 contingencies to further test the Griffith Mitigation Procedure that was identified in the Feasibility Study. In order to run these contingencies, the first contingency was taken and the case was saved with that line out of service. All of the remaining contingencies were run on that case and monitored against the NERC C criteria above. Since, adjustments can be performed to secure reliability after the first N-1, it did not make sense to stress the system with the Liberty phase shifter holding its maximum flow for the N-1-1 analysis. Therefore this test was only performed on the pre-Project and post-Project cases with the phase shifter bypassed.

Western's tariff also mandates that the Project be able to maintain a power factor within the range of 0.95 leading to 0.95 lagging at the plant's point of interconnection to Western's system. The documentation submitted with the customer's application suggests that it is only able to maintain a power factor in this range at the low side of the interconnection transformer. In order to test whether the project needs to install additional reactive capability, the post-Project case with the Liberty phase shifter was also used. A synchronous condenser was inserted at the low voltage terminal of the interconnection transformer and set to regulate the voltage of that bus. The voltage was varied in order to see what reactive power the Project might be capable of at the point of interconnection.

4.2 Transient Stability

Transient stability analysis is a time-based simulation that assesses performance of the power system during (and shortly following) a contingency. Transient stability studies were performed to ensure system stability following a critical fault on the system. Transient stability analysis was completed for pre-Project and post-Project cases with the Liberty phase shifter bypassed. Transient stability was not performed on cases with the phase shifter holding maximum flow in order to reduce the amount of processing time, and based on the power flow results there did not seem to be a need for this additional sensitivity in transient simulations.

Transient stability analysis, based on WECC Disturbance-Performance Criteria, was performed for selected system contingencies. Simulations were performed out to 10 seconds. Under normal clearing times for NERC Category B and Category C contingencies, 5 cycle fault clearing time was assumed. Under delayed clearing times for NERC C contingencies (stuck breakers), a 15 cycle fault clearing time was used.

Table 4 and **Figure 2** are excerpts from the WECC System Performance Criteria and were employed for this study.

NERC and WECC Categories	Outage Frequency Associated with the Performance Category (outage/year)	Transient Voltage Dip Criteria	Minimum Transient Frequency Criteria	Post Transient Voltage Deviation Criteria
A System normal	Not Applicable	Nothing in addition to NERC		
B One element out of service	≥ 0.33	Not to exceed 25% at load buses or 30% at non-load buses. Not to exceed 20% for more than 20 cycles at load buses.	Not below 59.6Hz for 6 cycles or more at a load bus.	Not to exceed 5% at any bus.
C Two or more elements out of service	0.033 – 0.33	Not to exceed 30% at any bus. Not to exceed 20% for more than 40 cycles at load buses.	Not below 59.0Hz for 6 cycles or more at a load bus.	Not to exceed 10% at any bus.
D Extreme multiple-element outages	< 0.033	Nothing in addition to NERC		

Table 3 – WECC System Performance Criteria

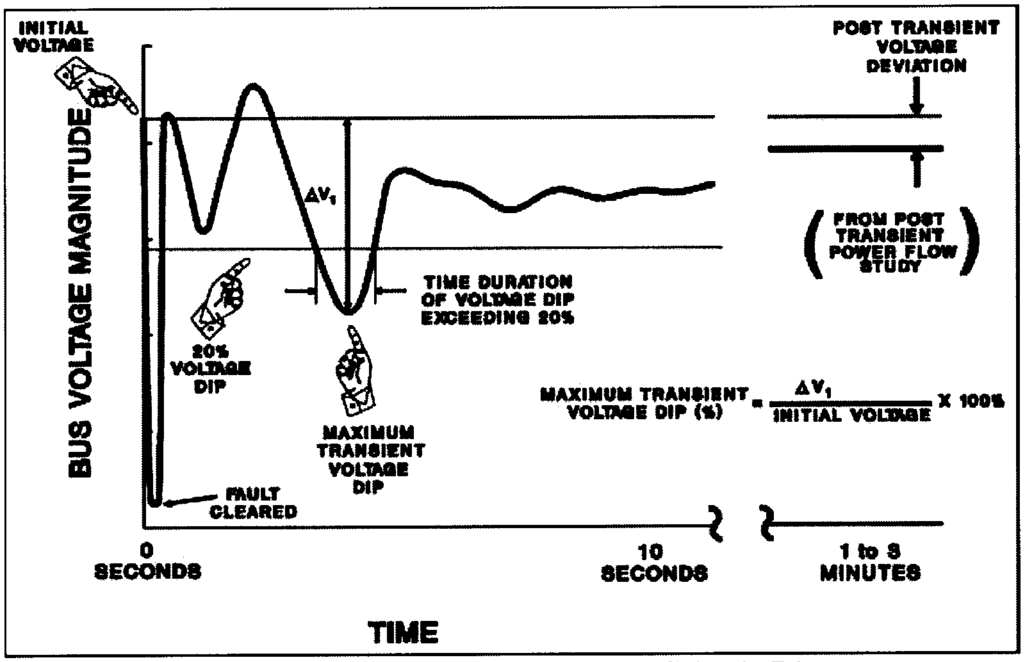

Figure 2 – WECC System Performance Criteria Diagram

All transient stability simulations were conducted using version 18 of GE's PSLF software. A modified version of the WECC-distributed Alldyns.p program was used to model operations specific to transient stability analysis.

The Worst Condition Analysis (WCA) tool, available in the GE PSLF software package, tracks and records the transient stability behavior of all output channels contained within the binary output file of a transient stability simulation. The monitoring of channel output was set to begin three cycles after fault clearing to ensure that all stability behavior would be accurately captured. The output results from the WCA program were used to report any NERC/WECC Performance Criteria violations. System damping was assessed visually with the aid of stability plots obtained through GE PSLF software.

The following describe the monitored parameters used to evaluate system stability performance:

- **Generator Speed**

  Generator speed plots provide a measure for determining how the proposed generation unit would swing with respect to other generation units in the area. This information can be useful in determining if a machine would remain in synchronism or goes out-of-step following a disturbance.

- **Bus Voltage**

  Bus voltage plots, in conjunction with the relative rotor angle plots, provide a means of detecting out-of-step conditions. The bus voltage plots are useful in assessing the magnitude and duration of post disturbance voltage dips and peak-to-peak voltage oscillations. Bus voltage plots also give an indication of system damping and the level to which voltages are expected to recover in steady state conditions.

- **Bus Frequency**

  Bus frequency plots provide information on magnitude and duration of post fault frequency swings. These plots indicate the extent of possible over-frequency or under-frequency, which can occur because of an imbalance between generation and load within an area.

- **Other Parameters Monitored**
  - Generator Terminal Voltage
  - Generator Frequency

4.3 Short-Circuit Duty

The short-circuit studies examined three-phase bus faults on the system two transmission stations from the Project. This includes Griffith, Peacock, and McConnico substations at all voltage levels.

Short-circuit analysis of the study system used the GE PSLF software to simulate the short-circuit study, with relevant Project modeling data supplied by the Project and other queue projects. The supplied dynamics data was used. The short-circuit study cases were the same four as those used in the power flow study. It should be noted that this is not an ANSI or IEC breaker duty evaluation.

The analysis compared bus fault currents in the pre-Project and post-Project conditions. The short-circuit results was based on the industry's practice of having all branches in-service, all line series compensation in-service, fault protection modeled for series capacitors, relevant phase-shifters bypassed, and all generators on-line. For the post-Project study cases, this included having the Project's generating unit on-line.

5 RESULTS

This section of the report provides results obtained in utilizing the above assumptions and methodology. It illustrates all findings associated with the power flow, transient stability and short circuit analysis. The results are also provided in Appendices C and D.

5.1 Power Flow

5.1.1 Thermal Loading Results

For Category B events in the case with the Liberty phase shifter holding its maximum flow, the McConnico – Davis 230 kV line overloads by about 2.5% after a contingency of the Peacock – Prescott 230 kV line. The Project increases the flow on the McConnico – Davis 230 kV line by less than 5% after this contingency. Since this is a small amount and only appears in extreme stressing, it may not be significant enough to justify an upgrade to the McConnico – Davis 230 kV line. The Peacock – Prescott 230 kV line also overloaded after contingencies, but the overloads are present in the pre-Project and post-Project scenarios and the project only adds a small amount of flow (less than 3%) to the existing overloads. The pre-existing overloads will need to be resolved by running back higher priority queue generation in this scenario.

In the case with the Liberty phase shifter bypassed, there are some overloads after Category B events but the overloads are present in the pre-Project and post-Project scenarios and the project only adds a small amount of flow to the existing overloads. Presumably, higher priority queue projects will make system upgrades or limit their generation output so that these pre-existing overloads do not occur.

For Category C events with the Liberty phase shifter holding its maximum flow, there are existing overloads after several contingencies. For most of these, the Project only adds a small amount of flow to the existing overloads. Higher priority queue projects must be reduced for these Category C contingencies and thus the contribution of the Project does not justify upgrades at this time. The most significant impact from the Project is that it increases the flow on the McConnico – Davis 230 kV line by more than 5% with a common corridor outage of the Perkins – Mead 500 kV and Mead – Peacock 345 kV lines. Breaker failures at higher priority queue project interconnection points along the Mead – Peacock 345 kV line similarly overload the McConnico – Davis 230 kV line. These overloads may need to be addressed if G7 or G27 queue projects leave the queue.

For the cases with the Liberty phase shifter bypassed, there are some overloads after Category C Common Corridor outages, but the overloads are present in the pre-Project and post-Project scenarios and the project only adds a negligible amount of flow to the existing overloads.

Finally, the N-1-1 analysis demonstrated that the Project contributes to several N-1-1 Category C flow overloads above the emergency ratings of several facilities. The Project increases the flow overloads by 5-10% in the scenarios listed below. However, all of these overloads are present in the pre-Project condition and would be resolved by system upgrades or curtailments associated with higher priority queue projects. In the event that the G7 or G27 queue projects leave the queue, the Project will need to be restudied to test whether it needs to be curtailed in initially out of service conditions.

Facility Initially Out of Service	Contingency	Potential Overloads
Mead 230/345 kV Transformer	McConnico – Davis 230 kV	Liberty- Liberty Phase shifter 230 kV line, and Peacock – Liberty 345 kV line
McConnico – Davis 230 kV	Mead 230/345 kV Transformer or Queue G7- G27 345 kV line	Liberty- Liberty Phase shifter 230 kV line, and Peacock – Liberty 345 kV line
Queue project G7 on Mead – Peacock 345 kV line	McConnico – Griffith 230 kV	Liberty- Liberty Phase shifter 230 kV line, and Peacock – Liberty 345 kV line
McConnico – Griffith 230 kV	Mead 230/345 kV Transformer or Queue G7- G27 345 kV line	Liberty- Liberty Phase shifter 230 kV line, and Peacock – Liberty 345 kV line

Table 4 – Facilities Most Impacted by N-1-1 Contingencies

5.1.2 Voltage Violation Results

The Project was only found to contribute to voltage violations in the N-1-1 analysis. When the McConnico-Davis 230 kV line or Mead 230/345 kV transformer is out of service, the contingency of other will cause the voltage to drop just below 90% on the Peacock 345 kV bus or Round Valley Tap 230 kV bus. The Project causes the voltage drop at these buses to increase by about 2% more than pre-Project conditions. However, under this configuration, the generation in the Peacock vicinity is high and the higher priority queue generation will need to be reduced after the first N-1. Thus, this voltage violation should be resolved by the mitigating procedures of higher priority queue projects.

5.1.3 Post-Transient Voltage Deviations

The Project was not found to contribute to any voltage deviation violations in any of the cases studied.

5.1.4 Power Factor

The table below summarizes the power factor ranges which the Project will likely be able to operate within. It was found that the Project might only have capability to operate between 0.92 lagging and 0.97 leading power factor at the point of interconnection. In order to reach the required range of 0.95 lagging to 0.95 leading, the project would have to install about 4 Mvar of capacitance at the point of interconnection or use an inverter technology that can operate at 0.92 leading power factor on the low side of the interconnection transformer. However, in the scenarios studied, the voltage is within acceptable ranges at the point of interconnection and adding additional reactive support would cause the voltage to rise too high. Therefore, there is not a reliability need to install more reactive support at this time.

Low Side				Point of Interconnection			
P	**Q**	**Voltage PU**	**PF**	**P**	**Q**	**PF**	**Additional Q Needed**
49.2	16.1	1.061	0.95 Leading	49.1	12.3	0.97 Leading	4 Mvar
49.1	-16.2	0.992	0.95 Lagging	48.9	-20.7	0.92 Lagging	None
49.2	20.4	1.07	0.92 Leading	49.1	16.4	0.95 Leading	4 Mvar
49.1	-11.9	1.002	0.97 Lagging	49	-16.1	0.95 Lagging	None

Table 5 – Power Factor Analysis

5.2 Transient Stability Analysis

All NERC Category B and NERC Category C contingencies with normal clearing showed sufficient damping with no WECC System Performance Criteria violations. However, delayed clearing (stuck breaker) contingencies at Griffith 230 kV and McConnico 230 kV led to system instability without out of step protection in service on the Griffith generators. This appeared in both pre-Project and post-Project conditions. To determine a reliable operating level without out of step protection, the output level of Griffith and the Project were adjusted in the post-Project condition as a stuck break contingency was run on Griffith breaker 482. The table below summarizes these results.

Griffith Output Level (MW)	Project Output Level (MW)	Stability Problem?
500	50	Yes, low voltage dips at Peacock, Round Valley, and Hilltop, undamped oscillations
500	0	Yes, low voltage dips at Peacock, Round Valley, and Hilltop, undamped oscillations
450	50	Yes, undamped oscillations
450	0	Yes, undamped oscillations
400	50	No, system stable
400	0	No, system stable
410	0	Yes, undamped oscillations

Table 6 - Stability Performance During Griffith Stuck Breaker #482 Contingency

Without out of step protection on the Griffith generator, the Griffith plant must be restricted to 400 MW. However, at this level it made no difference whether the Project was at full output or curtailed entirely. Therefore the Project will not likely need to share in reductions if out of step protection is lost at Griffith. Also, note that no reliability limit was reached when out of step protection is in service at Griffith.

For the transient stability N-1-1 analysis, it was found that the Project can reliably operate at full output with Griffith at 500 MW output in all tested initially out of service conditions. This result is true regardless of whether Griffith has functioning out of step protection. This result appears to contradict Western's existing operating procedure that requires the curtailments of the Griffith and Black Mountain generation to maintain system stability during initially out of service conditions (a summary of the curtailments is provided in the table below). Western is currently reviewing this procedure.

Facility Initially Out of Service	Max Allowable Generation Flows into Griffith 230kV
Griffith-Peacock 230 kV	300 MW
Griffith-McConnico 230 kV	300 MW
Peacock – Mead 345 kV	275 MW
Peacock 345/230 kV	275 MW
Mead 345/230 kV	275 MW
Davis – McConnico 230 kV	300 MW
Hilltop – McConnico 230 kV	Limit Not Defined

Table 7 – Summary of Operating Limits in SOP 4661

5.3 Short Circuit Duty

The short-circuit analysis demonstrates that the project does not significantly affect fault currents in the vicinity of the project. The table below provides a comparison of fault currents calculated at selected buses for both the pre-Project and post-Project conditions.

	Bus		Three Phase Fault Value Pre-Project (A)	Three Phase Fault Value Post-Project (A)	Delta (A)
Phase Shifter at Maximum	19056	McConnico 230 kV	12615	12559	-26
	19310	Griffith 230 kV	13454	13421	-30
	19311	Griffith 18 kV (max)	109707	109365	-342
	19314	Peacock 230 kV	12158	12137	-21

	19315	Peacock 345 kV	8221	8212	-9
Phase Shifter Bypassed	19056	McConnico 230 kV	12888	12882	-6
	19310	Griffith 230 kV	13739	13729	-10
	19311	Griffith 18 kV (max)	111079	110900	-179
	19314	Peacock 230 kV	12722	12714	-8
	19315	Peacock 345 kV	8983	8978	-4.5

Table 8 – Short Circuit Results

6 COST AND SCHEDULE ESTIMATE

The total estimated facility cost for the interconnection is summarized below. The facility cost estimates include design, construction, and environmental estimates.

Task	Cost ($)
Griffith Substation	3,000,000
Total Cost	3,000,000

Table 9 – Cost Estimate

Notes and assumptions:

1. Estimate does not include any lands or environmental activities
2. Assumes Project will be constructing the generation tie-line
3. Western will construct all items from the first pole outside of the substation and any existing tie-line adjustments to get to the substation.
4. No construction contract can be awarded until all environmental activities have been completed
5. Conceptual estimate is for substation work only

Both the cost and schedule estimates are relatively high-level, appropriate to a system impact study, and would be refined in the facility study. Western will work with the customer's schedule to coordinate the Project's in service date, but construction should take two to three years not including environmental activities.

7 CONCLUSIONS

Overall, the steady-state power flow, transient, and short-circuit results indicate that the Project can reliably inject its full output of 50 MW at the proposed interconnection point. The results show that no system upgrades are necessary beyond the Project interconnection point. The total estimated cost of this upgrade and construction at the point of interconnection is about $3 million, and will take about two to three years to complete, not including lands and environmental activities.

The results and conclusions of this system impact study are based on the assumption that higher priority queue projects and associated upgrades will be in service prior to the interconnection of the requested Project. In the event that any higher priority queue project exits the queue, this system impact study may need to be reassessed.

Finally, nothing in this report constitutes an offer of transmission service or confers upon the requested interconnection any right to receive transmission service. This system impact study tries to identify and mitigate only those possible new technical reliability violations of the interconnected system identified in a limited set of simulations. Despite the results of these technical interconnection studies, the Western system and other interconnected utilities may not have the contractual available transmission capacity (ATC) to support the interconnection described in this report. In fact, no transmission service request has been made by this project nor has any possible transmission service associated with this project been evaluated as part of this system impact study.